Environmental radioactivity during 50 years

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Publication date:
2013

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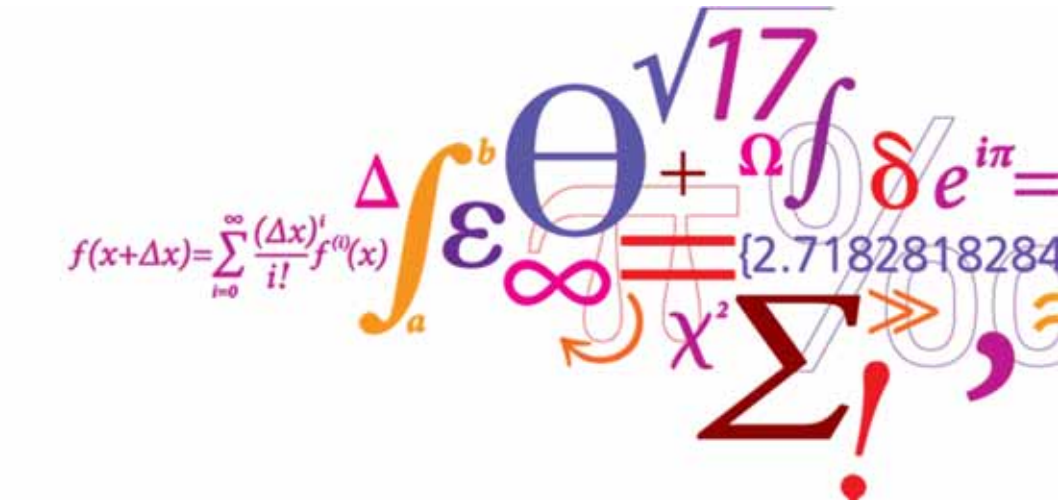
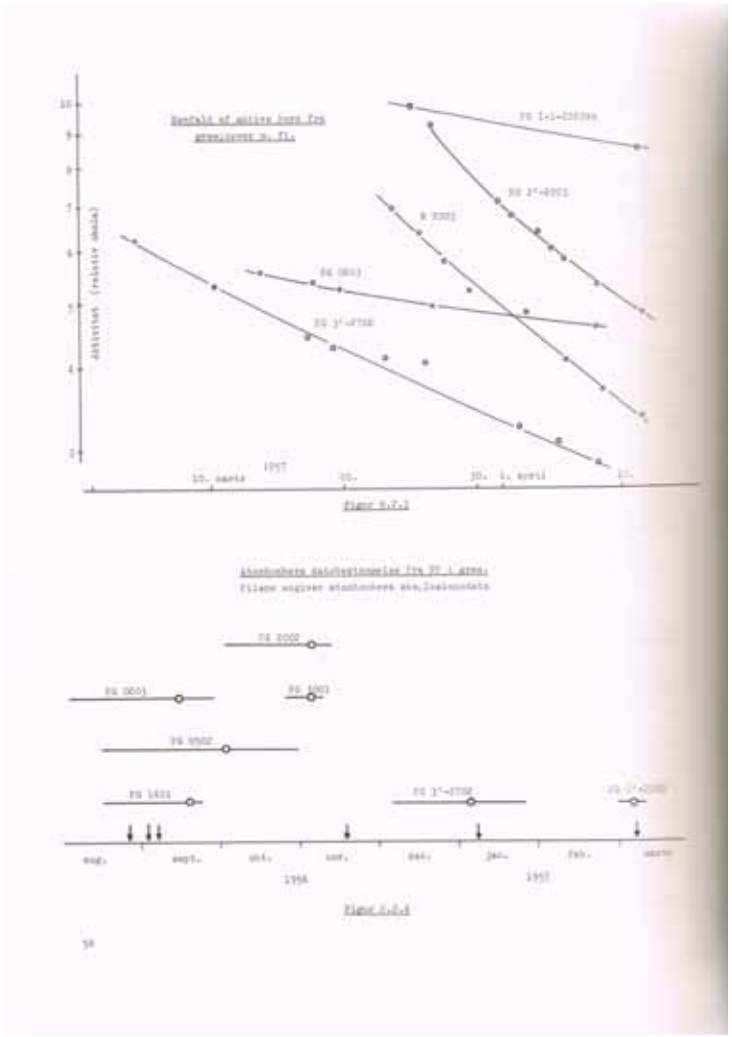


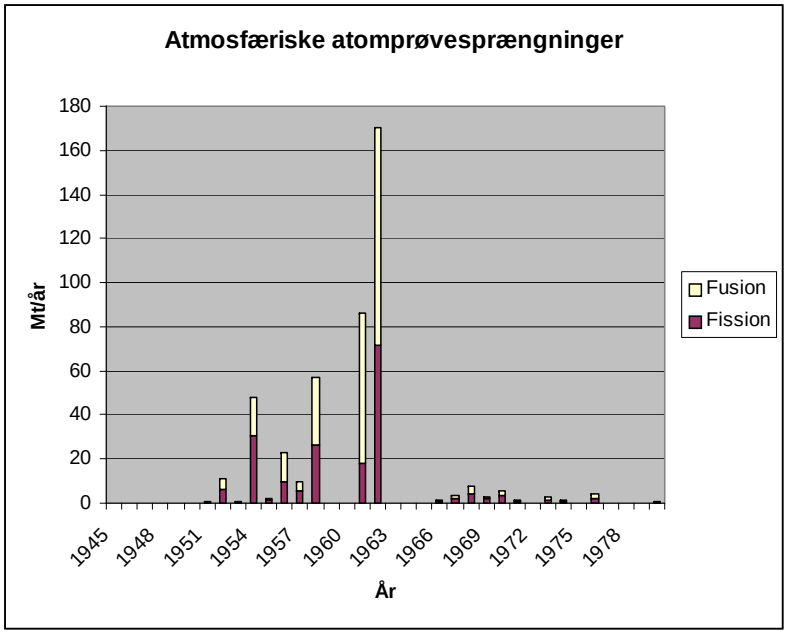
DTU Nutech
Center for Nuclear Technologies

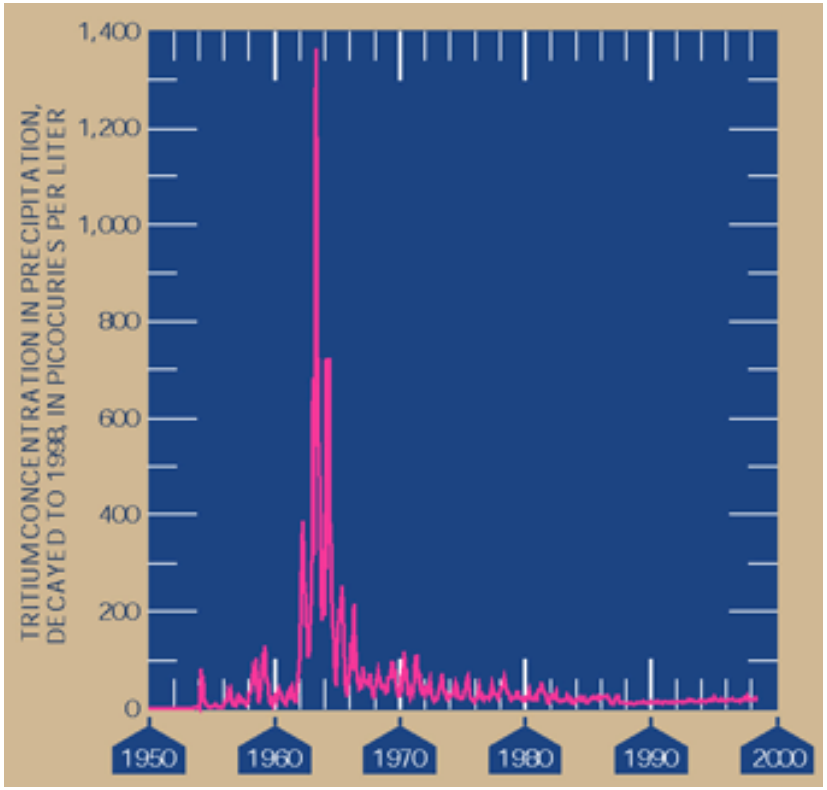
Investigations of man-made radioactivity in the Danish environment from 1957

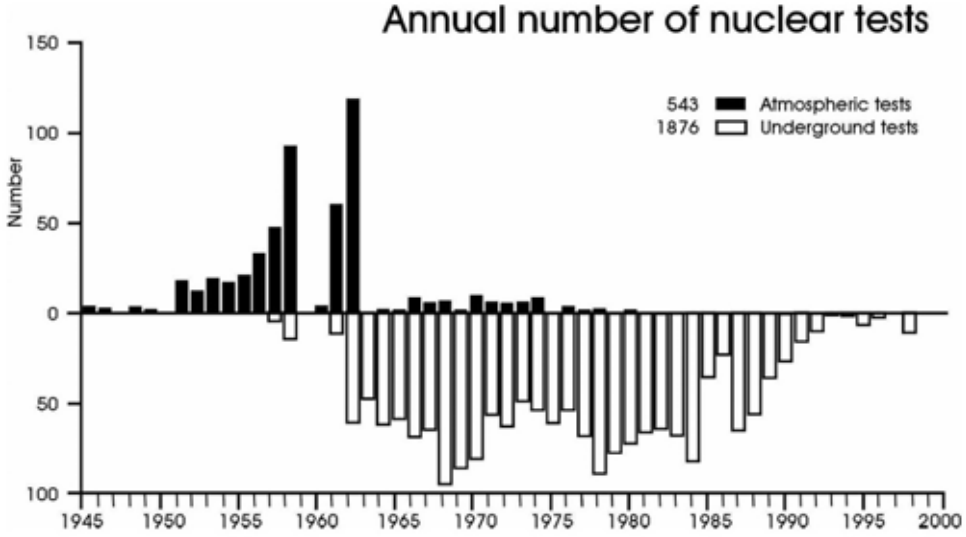


Atmospheric nuclear weapons tests

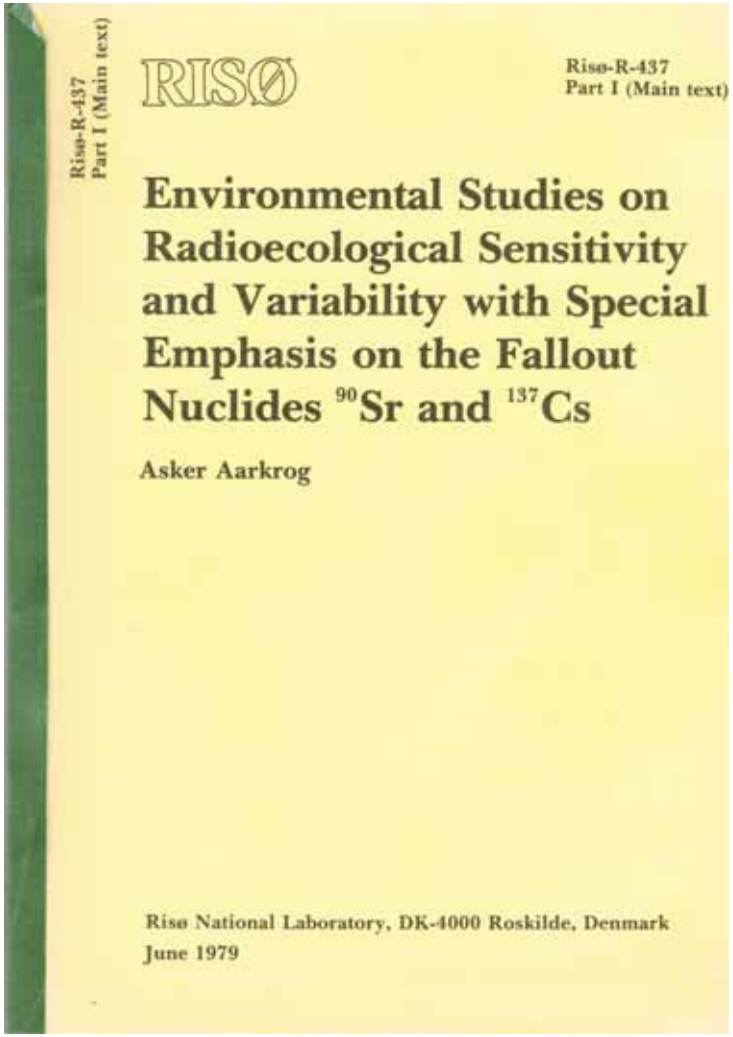
Global pollution from atmospheric nuclear weapons tests: fission products, activation products, fissile material and tritium







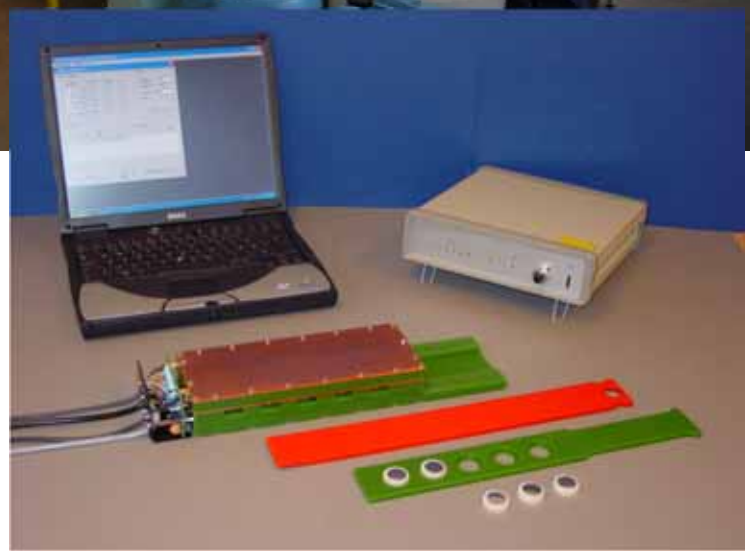
Radioecological sensitivity



- Studies covering
  - Air, water, soil
  - Grain, bread
  - Grass
  - Vegetables and fruit
  - Sea plants
  - Milk, meat, fish
  - Total diet
  - Human body, bone
- Radioecological sensitivity is the time integral of quantities of the sample type from a quantity of the radionuclide deposited
- Example for Cs-137 in Danish cow's milk
  - 2.0 Bq/L d per Bq/m^2

Strontium-90 and caesium-137

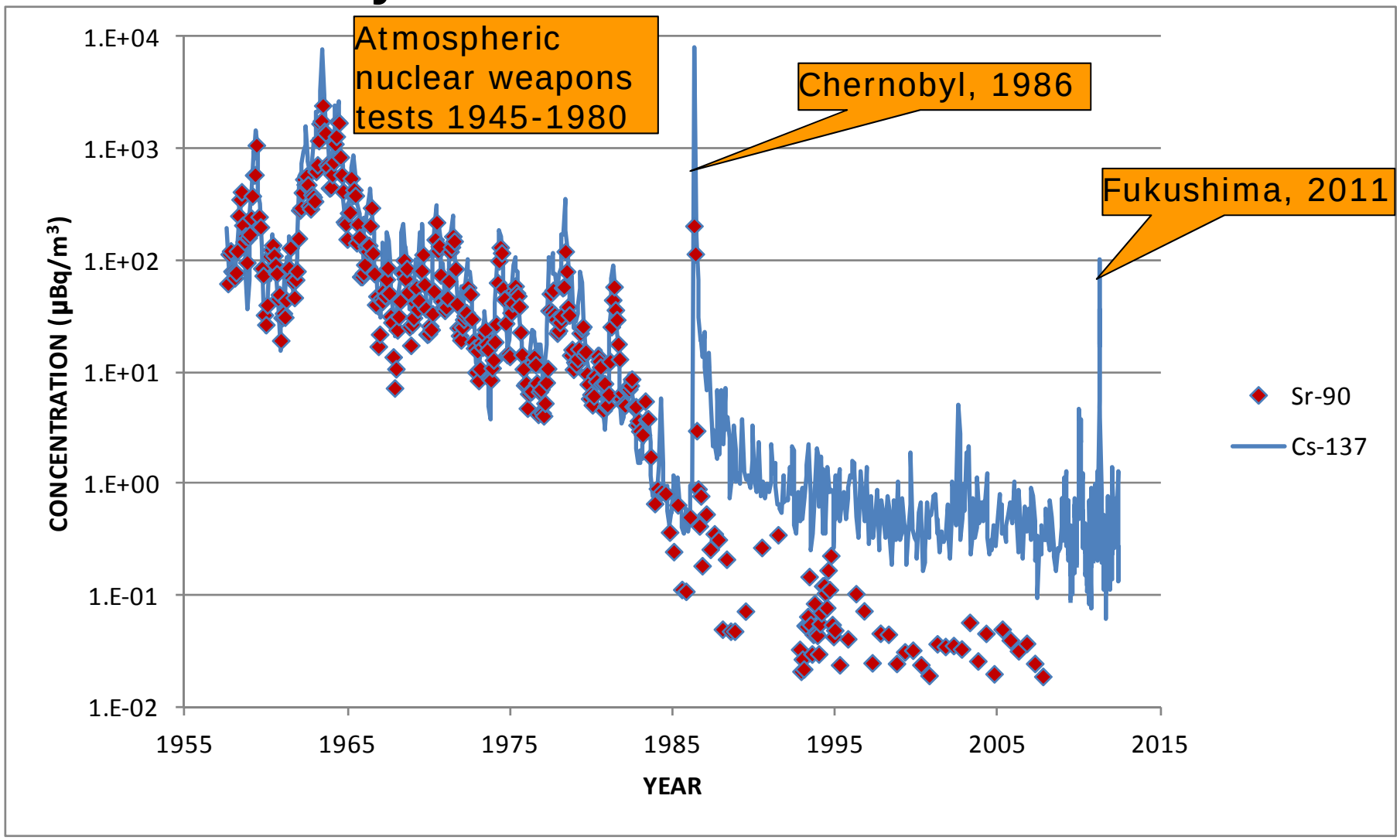
- Fission products of particular importance due to long half lives and significant uptake in food chains



Aerosols

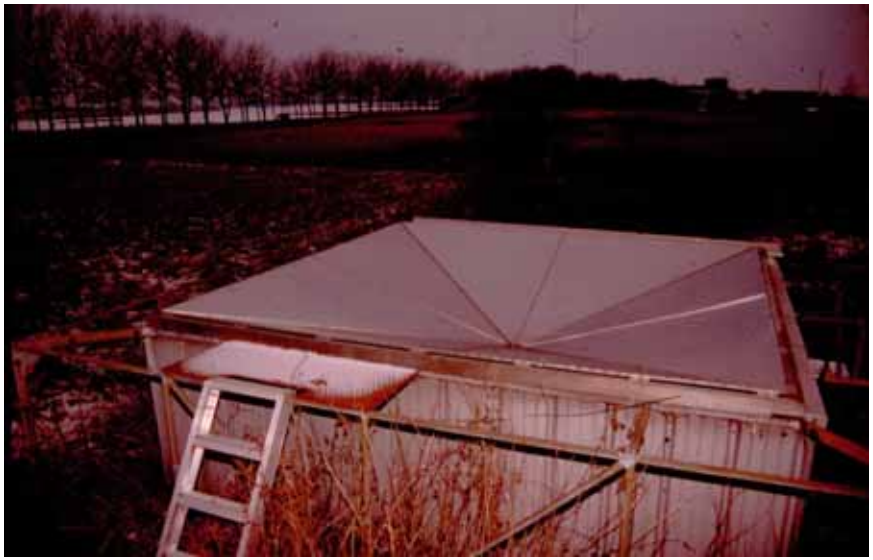
- Monitoring of radioactivity in air is based on aerosol collectors located in Haderslev, Allinge and Risø.
- Air is sampled at flow rates of 500-2000 m^3/h through organic filters retaining particles
- Filters are changed weekly and analysed for short-lived radionuclides first and later for longer lived radionuclides, particularly ^{7}Be, ^{210}Pb, ^{90}Sr, ^{137}Cs.

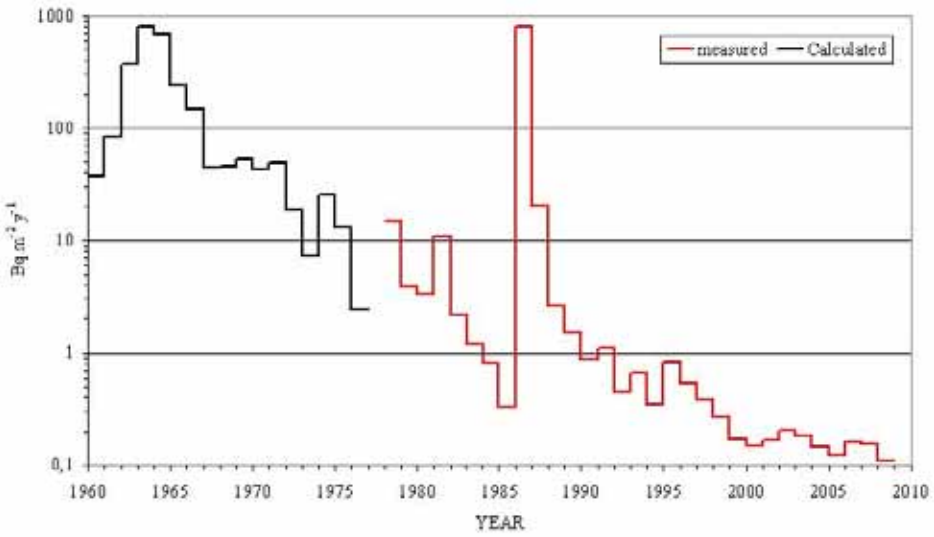
Radioactivity in Air at Risø



Precipitation

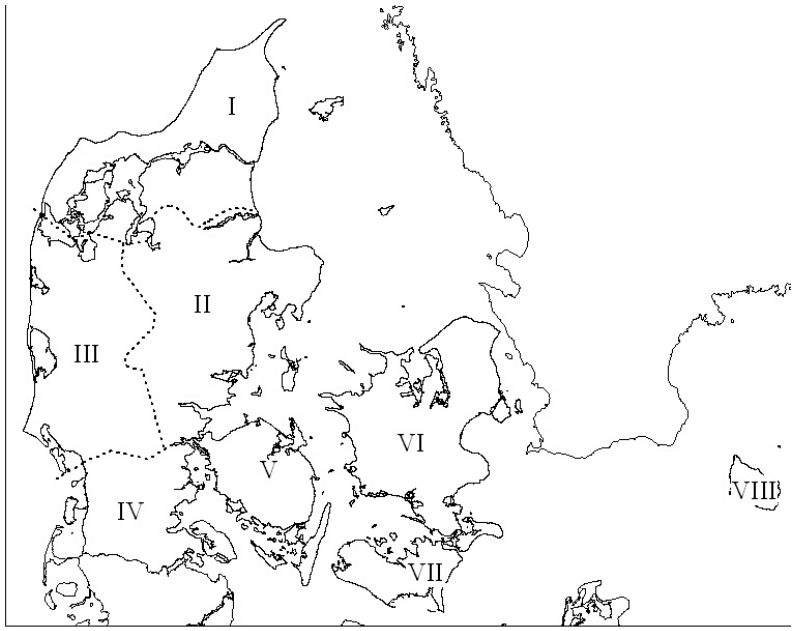
Precipitation is collected at Risø and 10 other locations in Denmark and analysed for content of Sr-90 and Cs-137



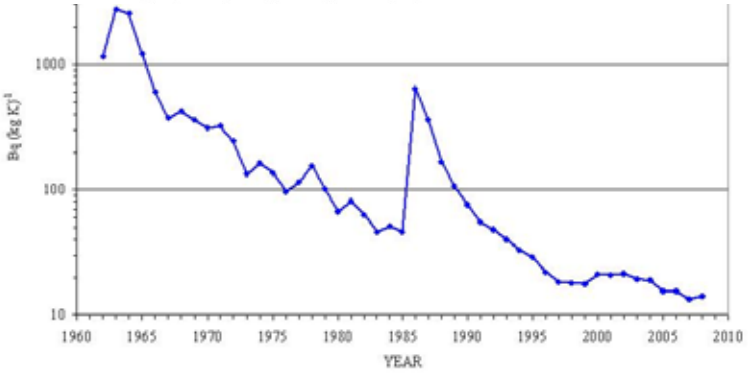


Caesium-137 in precipitation at Risø, 1960-2009

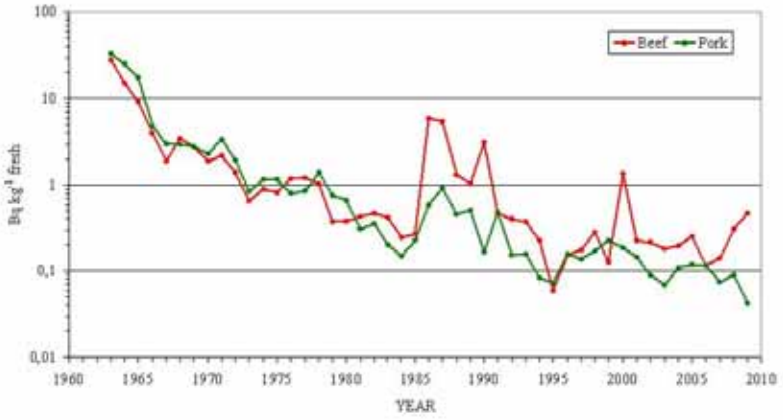
Milk, potatoes, vegetables and total diet



Sampling zones (I-VIII) for milk, potatoes, vegetables and total diet in Denmark.

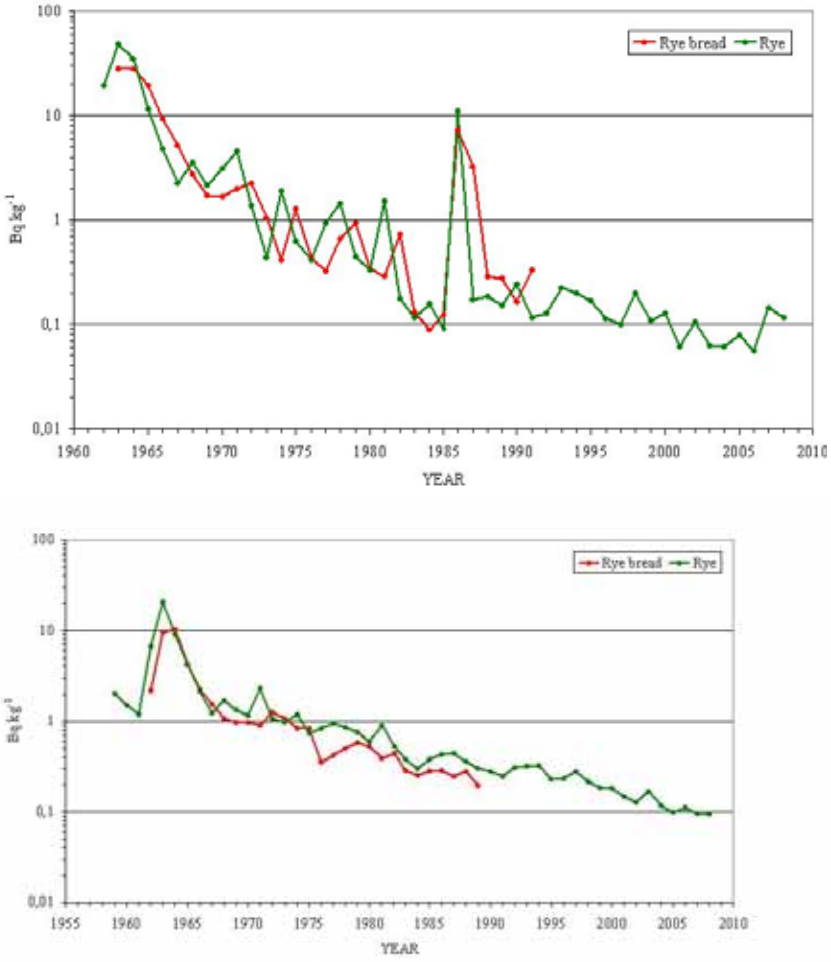


Caesium-137 in milk collected in 1962-2008.

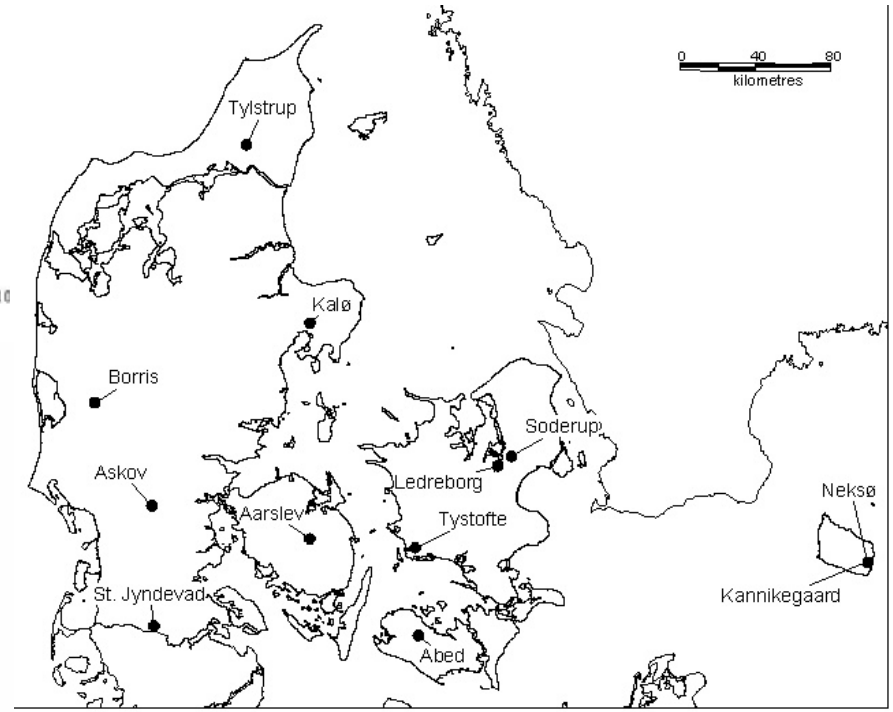


Caesium-137 in beef and pork collected in 1963-2009

Cereals: rye, oats, wheat, barley

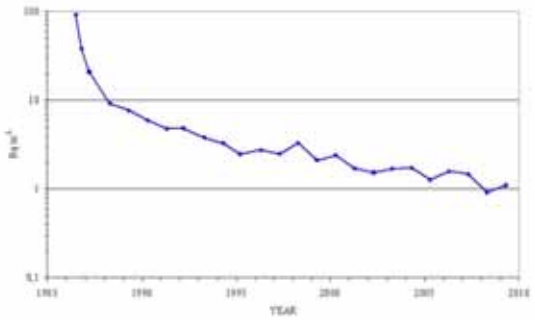


Strontium-90 in rye collected in 1959-2008 and in rye bread collected in 1962-1990.



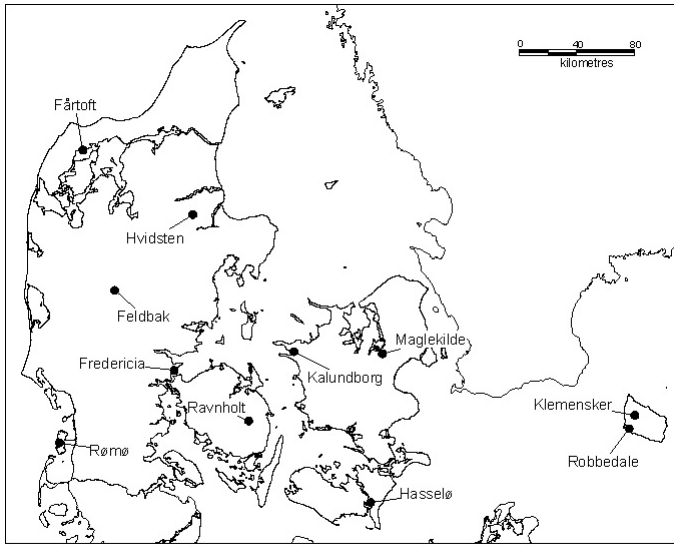
Grain sampling locations (State experimental farms in Denmark)

Stream, lake and ground water



Caesium-137 in lake water, 1986-2009

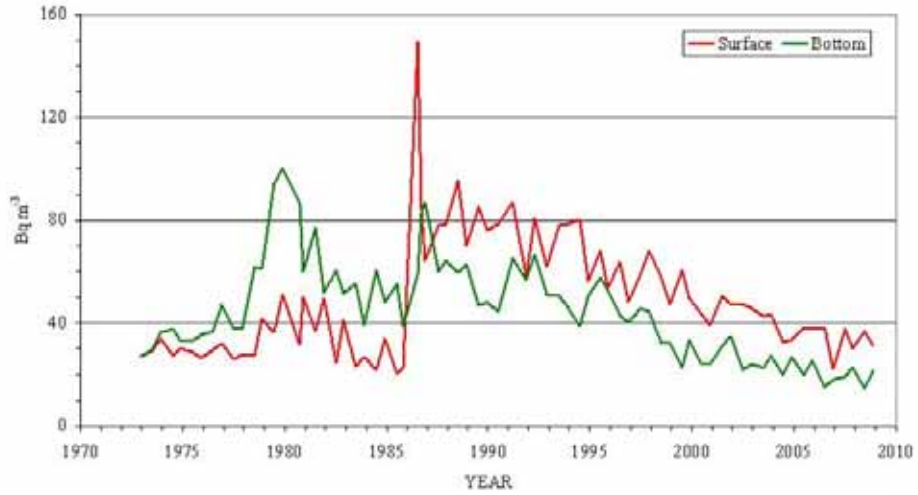
Strontium-90 in groundwater, 1961-2007.

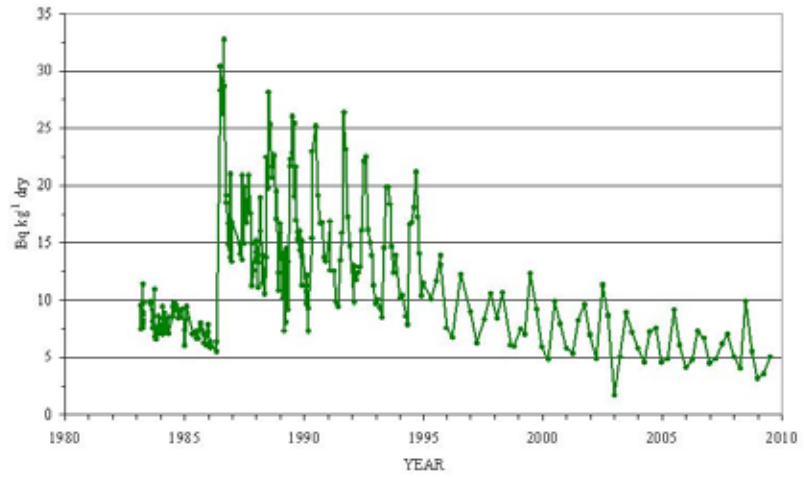


Sampling locations for ground water in Denmark

Sampling locations for fresh water from Danish streams (å) and lakes (sø).

Sea water and plants





Caesium-137 in seaweed (Fucus vesiculosus and Fucus seratus) from February 1983 to June 2009 collected at Klint, Zealand (55°58'N, 11°35'E).

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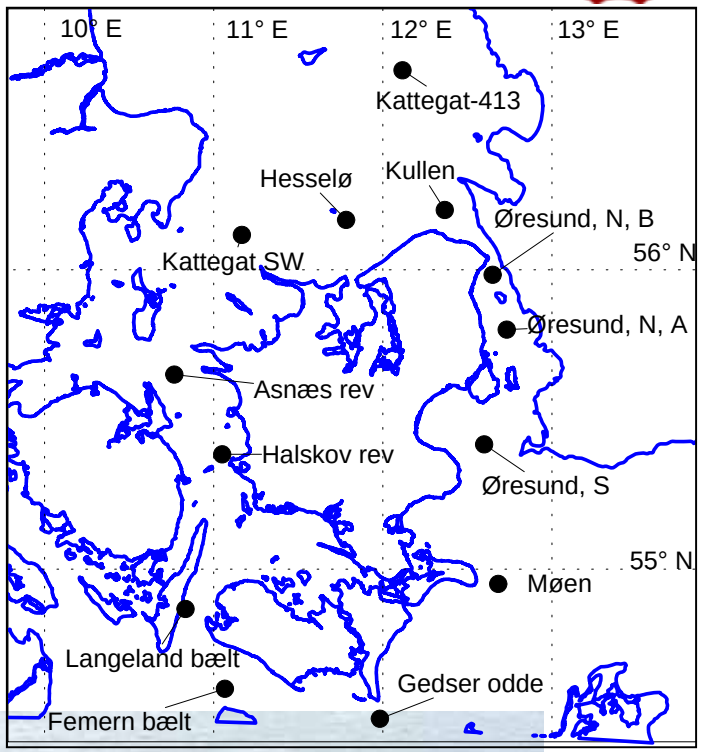
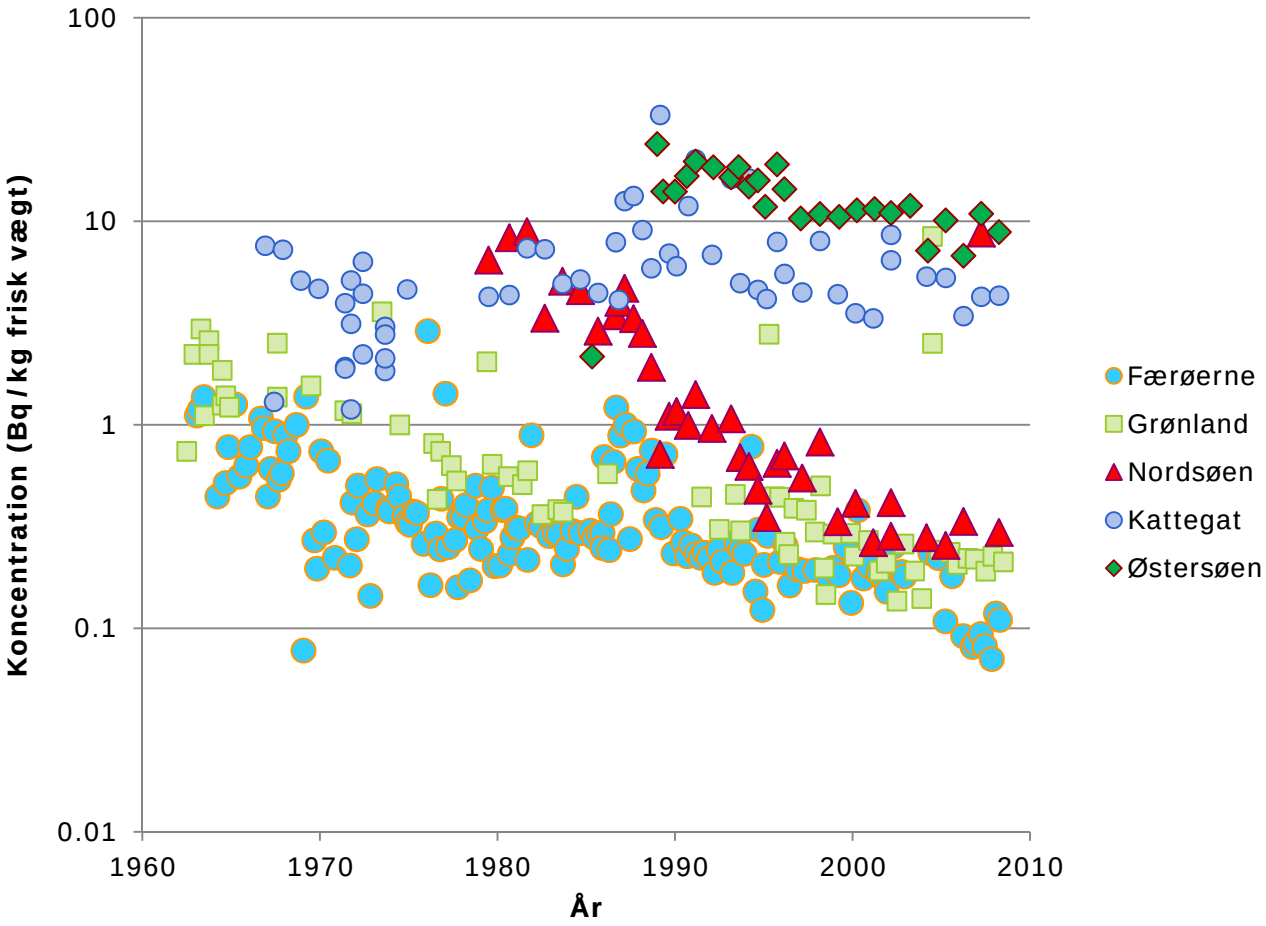
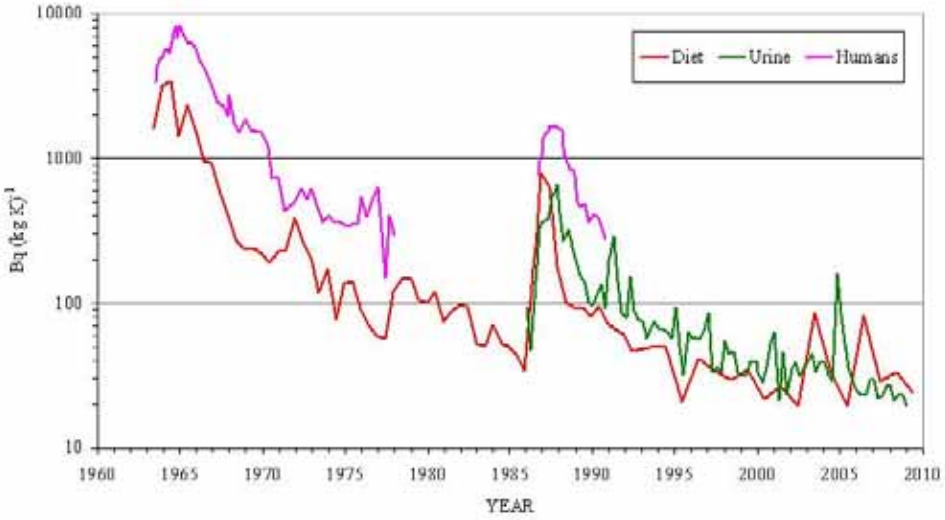


Caesium-137 in fish / cod

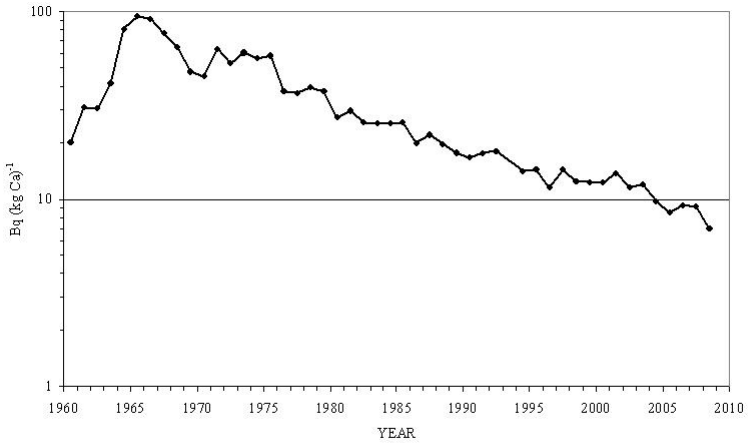


Humans

- Employees at Risø monitored for radiocaesium and tritium
- Human bone samples received from hospitals (with difficulty)

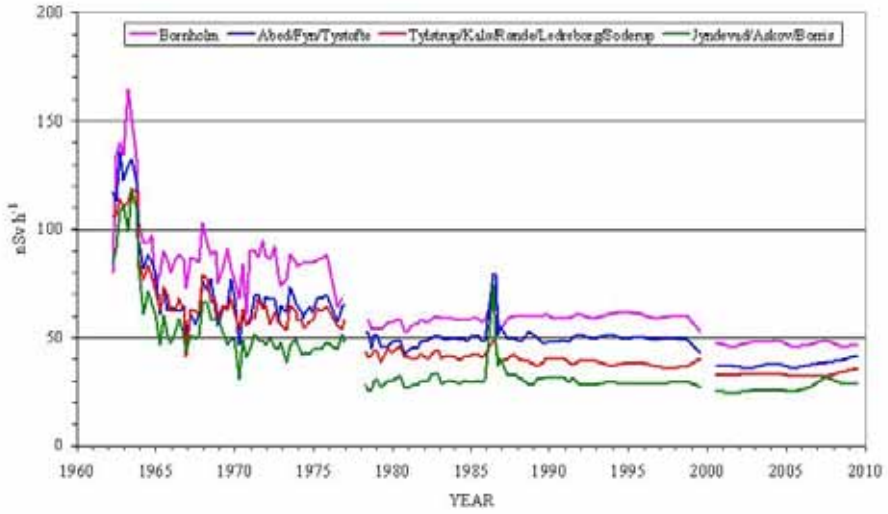


Radiocaesium (Bq ^{137}Cs (kg $K)^{-1}$) in diet, urine, and humans from Zealand in 1986-2009.

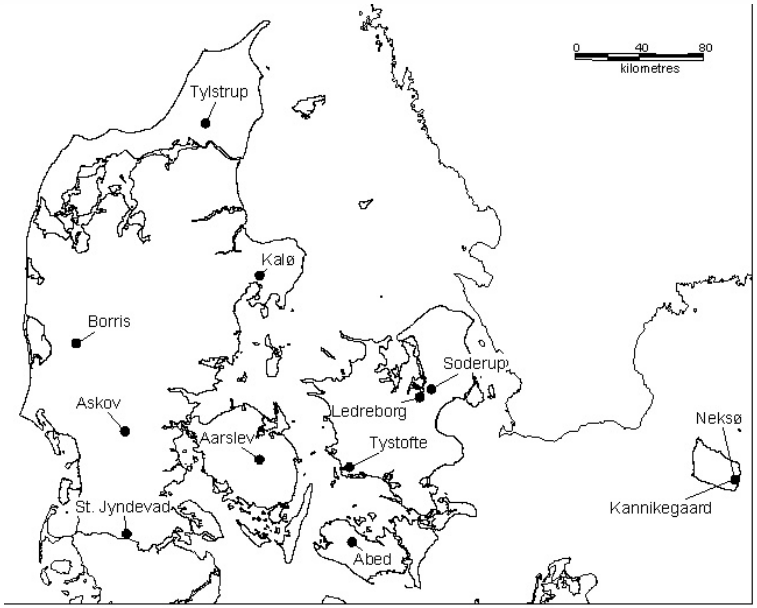


Strontium-90 levels in bone from adults (> 29 years) 1960-2009.

External exposure



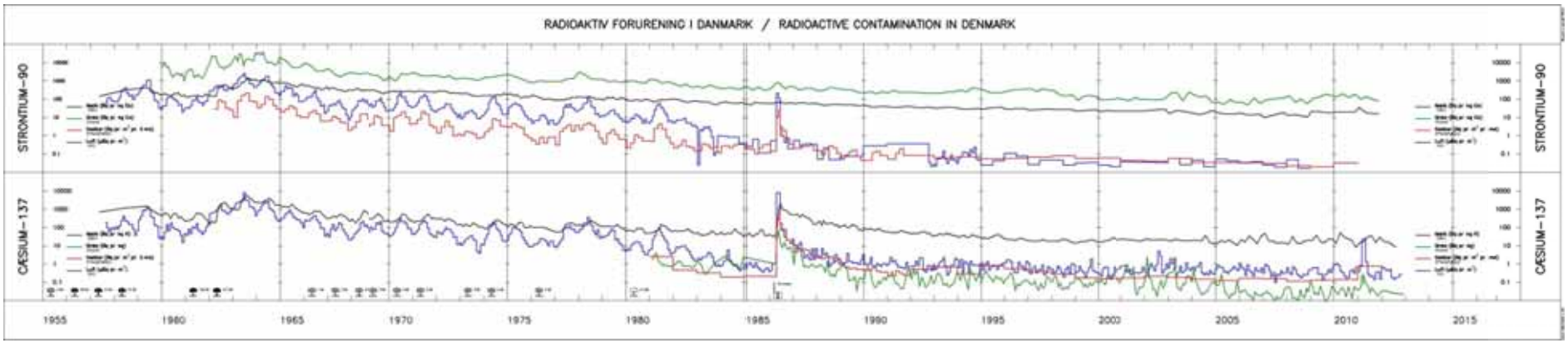
External exposure rates in 4 locations in Denmark, as measured with a NaI(Tl) detector.



Grain sampling locations (State experimental farms in Denmark)

Radioactive contamination in Denmark

- Poster in building 204 shows concentrations of strontium-90 and caesium-137 in air, precipitation, milk and grass at Risø and in Denmark since the 1950's
- Including input from the Fukushima accident in Japan in 2011



Why monitor environmental radioactivity?

- EURATOM Treaty: Health and safety matters - Obligation of EC Member States to monitor levels of radioactivity in air, soil and water and to ensure compliance with basic standards
- Helsinki Convention: Contracting Parties undertake to prevent and eliminate pollution of the marine environment of the Baltic Sea Area caused by harmful substances from all sources
- Study man-made and naturally occurring radionuclides in the environment to document baseline levels and increase knowledge on behaviour and processes
- Expertise available for emergency purposes in case of accidents/incidents involving release of radioactivity to environment
- Improve radiological assessment models in decision support systems used by authorities in case of accidents
- Useful platform for research and development of existing and new analytical methods and application of these in other areas